

☐ Fast Access ☐ Joint CINT Proposal

Program Advisory Subcommittee: Materials Science Focus Area:			
Flight Path/Instrument: Target 2 / Blue Room Estimated Beam Time (days): 5 Days Recommended: 0		Dates Desired: Impossible Dates:	
TITLE Experimental measurement of thermal neutron energy spectra produced by innovative neutron moderator materials		<input type="checkbox"/> Continuation of Proposal #: <input type="checkbox"/> Ph.D Thesis for:	
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RESEARCH AREA		FUNDING AGENCY	
<input type="checkbox"/> Biological and Life Science <input type="checkbox"/> Chemistry <input type="checkbox"/> National Security <input type="checkbox"/> Earth Sciences <input type="checkbox"/> Engineering <input type="checkbox"/> Environmental Sciences <input type="checkbox"/> Nuc. Physics/chemistry <input type="checkbox"/> Astrophysics <input type="checkbox"/> Few Body Physics <input type="checkbox"/> Fund. Physics <input type="checkbox"/> Elec. Device Testing <input type="checkbox"/> Dosimetry/Med/Bio <input type="checkbox"/> Earth/Space Sciences <input type="checkbox"/> Materials Properties/Test <input checked="" type="checkbox"/> Other: spallation physics		<input type="checkbox"/> Mat'l Science (incl Cond Matter) <input type="checkbox"/> Medical Applications <input type="checkbox"/> Nuclear Physics <input type="checkbox"/> Polymers <input type="checkbox"/> Physics (Excl Condensed Matter) <input type="checkbox"/> Instrument Development <input type="checkbox"/> Neutron Physics <input type="checkbox"/> Fission <input type="checkbox"/> Reactions <input type="checkbox"/> Spectroscopy <input type="checkbox"/> Nuc. Accel. Reactor Eng. <input type="checkbox"/> Def. Science/Weapons Physics <input type="checkbox"/> Radiography <input type="checkbox"/> Threat Reduction/Homeland Sec. <input type="checkbox"/> Other:	
		<input type="checkbox"/> DOE/BES <input type="checkbox"/> DOE/OBER <input checked="" type="checkbox"/> DOE/NNSA <input type="checkbox"/> DOE/NE <input type="checkbox"/> DOE/SC <input type="checkbox"/> DOE/Other <input type="checkbox"/> DOD <input type="checkbox"/> NSF <input type="checkbox"/> Industry <input type="checkbox"/> NASA <input type="checkbox"/> NIH <input type="checkbox"/> Foreign: <input type="checkbox"/> Other US Gov't: <input type="checkbox"/> Other:	

PUBLICATIONS**Publications:**

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NIMA 632 (2011) 101

Abstract: S1553_proposal.pdf

By electronic submission, the Principal Investigator certifies that this information is correct to the best of their knowledge.

Safety and Feasibility Review(*to be completed by LANSCE Instrument Scientist/Responsible*)☐ No further safety review required ☐ To be reviewed by Experiment Safety Committee☐ Approved by Experiment Safety Committee, Date:

Recommended # of days:

Change PAC Subcommittee and/or
Focus Area to:

Change Instrument to:

Comments for PAC to consider:

Instrument scientist signature:

Date:

Experimental measurement of thermal neutron energy spectra produced by innovative neutron moderator materials

The LANSCE spallation physics team has been working in the area of development of new moderator materials that will be superior to water (e.g., in terms of operational temperature range, thermal neutron production) for many years. Following a string of experiments done in the Blue Room (in 2008 and in 2010) we propose to carry out a series of experiments studying water and mesitylene loaded mesoporous SiO_2 . In the second part of our proposal we plan to experimentally measure the thermal neutron gain provided by using a backscattering moderator in a completely decoupled geometry.

Many neutron-scattering instruments served by water moderators (e.g., SMARTS, NPDF, HIPPO, etc.) would prefer a colder neutron energy spectrum than the produced thermal neutron spectrum. In the past, facilities have tried to accommodate this by using liquid methane moderators, however, methane in a radiation environment polymerizes and presents difficulties to operate such a moderator in a safe manner. In the 2008 experiment we have investigated possible alternatives to methane, namely, lead and bismuth hydroxides. While the results were encouraging in the sense that it was shown that the brightness of a moderator does not necessarily need to be strictly proportional to the hydrogen density in the material, a fact that still needs to be fully understood, we also realized that the materials have continued to oxidize even after this short irradiation. In the 2010 experiment we investigated water-loaded mesoporous SiO_2 . We saw a reduced neutron production with respect to a same-size water moderator. This experiment, as all our previous experiments, was carried out in a completely coupled geometry. This arrangement results in a maximum neutron production, however it is very difficult to disentangle the neutron moderation properties of the investigated moderator material from the contributions of the surrounding materials (beryllium reflector, other moderators). Therefore, we are proposing to modify the beryllium reflector assembly (utilized in 2003, 2008, and 2010 experiments) by adding layers of cadmium, decoupling the reflector from the investigated moderators. This will precisely separate the thermal neutron production in the investigated moderator materials from the contributions by the reflector assembly. Furthermore, we will ensure that all our samples have the same hydrogen content, enabling a more detailed study of neutron moderation fundamentals. We are planning to study mesitylene, water-loaded mesoporous SiO_2 , mesitylene-loaded SiO_2 and benchmark these data to water in the same geometry. Mesitylene is an interesting candidate for neutron moderator material as it has a very high radiation resistance [1] (unlike methane, or ammonia). It has been studied at cryogenic temperatures but there is not a lot of data available at room temperature. Hence, we expect to contribute a valuable experimental data set to the scientific community.

In the second part of our proposal we plan to investigate a decoupled backscattering flux-trap moderator arrangement. Preliminary MCNPX calculations indicated that this change could increase the flux for these instruments by a factor of 1.5 while minimally affecting the resolution. If this production boost can be confirmed experimentally, the concept will be implemented in the next-generation (Mark-IV) 1L TMRS design. Such an upgrade might keep the Lujan instruments an interesting alternative to SNS instruments for users.

It will divert the user's attention to other considerations like sample environment or services provided by the instrument scientist away from the raw accelerator power.

The scientific reason for the anticipated increase in thermal flux is due to the fact that in the slowing down process the highest losses in energy occur for the scattering angle of 180° (backscattering). Therefore, the thermalization process is most efficient in the backscattering direction. The concept of backscattering moderators is not completely new. The Lujan Center has operated two coupled backscattering moderators since the installation of the Mark-I version of the 1L TMRS. However, these are coupled and secondly, there has been a long on-going controversy about their performance. While some of these disagreements, in particular on the liquid hydrogen moderator have been laid to rest, the controversy around the coupled water backscattering moderator is still not solved to the satisfaction of all stakeholders. It also needs to be emphasized that no other facility is currently operating a backscattering moderator (neither coupled nor decoupled). It is therefore prudent, before implementing the concept of a decoupled backscattering moderator, to perform a proof of principle experiment. For this experiment we will reuse the decoupled beryllium reflector assembly (described above) with two decoupled water moderators.

The data from the 2003 experiment were presented at ICANS-XVI conference [2] and led to a publication in Nucl. Instr. and Meth. A [3]. The data of the 2008 experiment were presented at the ICANS-XIX conference [4] and a more detailed version appeared in Nucl. Instr. and Meth. A [5].

We have estimated that these measurements will take 4 days of beam time. We are planning to upgrade our neutron detection system using a large-area high-efficiency neutron detector. It will result in reduction of the time needed for individual runs, the proton beam current and the activation of the assembly. Using this technique we will be able to utilize the beam time more efficiently as in the previous experiments. In addition we estimate that we will need one day of cool down before the setup can be taken done, which brings the total request to 5 days.

References:

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- [2] E.J. Pitcher, G.J. Russell, G. Muhrer, J.J. Jarmer and R.K. Corzine, 16th Meeting of the International Collaboration on Advanced Neutron Sources, Düsseldorf-Neuss, Germany, May 12-15 2003, p. 849
- [3] G. Muhrer, M.A. Hartl, L.L. Daemen and J. Ryu, Nucl. Instr. and Meth. A **578** (2007) 463.
- [4] M. Mocko, L.L. Daemen, M. Hartl, Th. Huegle, G. Muhrer, The 19th Meeting of the International Collaboration on Advanced Neutron Sources, Grindelwald Switzerland, March 8-12, 2010
- [5] M. Mocko, L. L. Daemen, M. Hartl, Th. Huegle, G. Muhrer, Nucl. Instr. and Meth. A **624** (2010) 173